



Original communication

Toxicology findings in suicides: Concentrations of ethanol and other drugs in femoral blood in victims of hanging and poisoning in relation to age and gender of the deceased



Alan Wayne Jones, PhD, DSc^{a,b,*}, Anita Holmgren^a, Johan Ahlner, MD, PhD^{a,b}

^a Department of Forensic Genetics and Forensic Toxicology, National Board of Forensic Medicine, Linköping, Sweden

^b Department of Clinical Pharmacology, Linköping University, Faculty of Health Sciences, Linköping, Sweden

ARTICLE INFO

Article history:

Received 28 February 2013

Received in revised form

19 June 2013

Accepted 30 June 2013

Available online 8 August 2013

Keywords:

Alcohol

Blood

Drugs

Hanging

Poisoning

Suicides

Toxicology

ABSTRACT

Over-consumption of alcohol and/or abuse of other drugs are closely linked to attempted or completed suicides. In this retrospective 10-year study (2001–2010), we compared the toxicology findings in hanging suicides ($n = 4551$) with drug poisoning (intoxication) suicides ($n = 2468$). The mean age of hanging deaths was 49 ± 19 y (\pm SD) and 80% were male, compared with a mean age of 52 ± 17 y and 47% males for the intoxication deaths. Poly-drug use was more common in poisoning suicides with an average of 3.6 drugs/case compared with 1.8 drugs/case in hangings. Moreover, 31% of hangings were negative for alcohol and/or drugs. Alcohol was detected (>0.20 g/L) in femoral blood in 30% of hanging suicides (mean 1.39 g/L) and 36% of drug poisonings (mean 1.39 g/L). The median BACs did not depend on the person's age or gender ($p > 0.05$). Ethanol, paracetamol, citalopram, diazepam, propiomazine, alimemazine and zopiclone were amongst the top-ten drugs detected in both methods of suicide. With the exception of ethanol, the concentrations of drugs in blood were considerably higher in the poisoning deaths, as might be expected. Regardless of the method of suicide, antidepressants and/or antipsychotics were common findings, which could implicate mental health as a significant suicide risk factor.

© 2013 Elsevier Ltd and Faculty of Forensic and Legal Medicine. All rights reserved.

1. Introduction

Suicide is a major cause of unnatural death in most nations and this public health problem deserves close attention and scrutiny in order to decrease mortality rates. The risk factors for suicidal behaviour are many and varied and depend on the victims age, gender, mental health and other characteristics, including ethnicity.^{1–3} A prominent feature of many suicide deaths in Western nations is over-consumption of alcohol, as shown by elevated blood-alcohol concentrations (BAC) being frequently found at autopsy.^{4–6} Drunkenness leads to poor judgement and self control, people tend to become less inhibited, more impulsive and reckless, including self-harm, which in pre-disposed individuals might trigger a suicide attempt.^{7–9} The many environmental factors linked to propensity to commit suicide include long-term unemployment, family bereavement, divorce, business failures, media

coverage of suicides, internet activities and the economic recession.^{10–13}

During police investigations of suicide deaths, the toxicological analysis of blood and urine samples from the deceased provides important, often crucial, information when the manner of death is determined.^{5,14,15} Restricting the availability of certain over-the-counter drugs, such as paracetamol, a drug often implicated in poisoning suicides, has proven an effective preventative measure.^{16,17} A large body of research has focused on the demographics of suicide victims, the methods people use to take their own life and ways of prevention. Hanging deaths are common in male victims, whereas females prefer less violent deaths and resort to taking drug overdoses, although this depends on the person's age, maturity, nationality, and mental health status.^{18,19} For example, the drugs and poisons used by people living in India or China are dominated by agricultural chemicals, such as pesticides, whereas overdosing with alcohol and/or prescription drugs occurs in Sweden and other Nordic countries.^{20,21}

We undertook a retrospective database study to investigate the demographics and toxicology findings in hanging and poisoning suicides, so-called intoxication deaths. The cases were selected from International Classification of Disease Codes (ICD-9) assigned

* Corresponding author. Department of Forensic Genetics and Forensic Toxicology, National Board of Forensic Medicine, Artillerigatan 12, SE-587 58 Linköping, Sweden.

E-mail address: wayne.jones@liu.se (A.W. Jones).

by forensic pathologists following completion of the case, including autopsy findings, medical records, findings at the scene (e.g. suicide note), police investigations, interviews with spouse, neighbours, friends and/or relatives and also the results of toxicological analysis.

2. Material and methods

2.1. Forensic toxicology in Sweden

Forensic toxicology in Sweden (population 9.3 million) is centralized in a single accredited laboratory. The local police authorities request a forensic autopsy when a sudden and unexpected out-of-hospital death occurs or when circumstances suggest foul play. Forensic autopsies are performed at the six university teaching hospitals in Sweden and biological specimens are sent for toxicological analysis in special refrigerated containers.

We used an in-house database (TOXBASE) to retrieve information about age, gender and the concentrations of ethanol and other drugs determined in femoral blood in two types of suicide death, namely hangings ICD-9 code E 953 (hanging) and drug intoxication deaths ICD-9 code E 950.

2.2. Biological specimens

Specimens of femoral blood, urine, and vitreous humor were obtained at autopsy and submitted for analysis in tubes containing added potassium fluoride (2% wt/vol) as a preservative and enzyme inhibitor. We did not include cases if the body had undergone decomposition or if massive trauma and exsanguinations precluded obtaining specimens of femoral blood for analysis.

Between 2001 and 2010 forensic pathologists in Sweden classified $n = 11,539$ deaths as suicides. Of these $n = 4551$ (39%) were hangings and $n = 2468$ (21%) were drug poisonings, referred to as intoxication deaths. A broad range of analytical toxicology was applied to determine the concentrations of ethanol, illicit and prescription drugs in femoral blood samples. Suicide deaths resulting from carbon monoxide poisoning were not included in the study.

2.3. Determination of blood-ethanol

Blood-ethanol concentration was determined in duplicate by headspace gas chromatography using a well-established method as described in more detail elsewhere.²² However, in this study we used an analytical cut-off concentration of 0.20 g/L (20 mg/100 mL or 0.02 g%) in femoral blood to report positive alcohol results. There is a risk that small amounts of alcohol are generated in the body after death and use of a lower analytical cut-off, such as 0.1 g/L or 0.05 g/L would lead to an over-estimate of alcohol-positive cases.

2.4. Analysis of drugs other than ethanol

Analysis for drugs other than alcohol was accomplished by initial use of a broad screening analysis with immunoassay methods (EMIT and/or CEDIA), aimed at identifying presumptive positive cases. The screening is mainly intended to detect various classes of illicit drugs (amphetamines, opiates, cannabis, cocaine metabolite) and is done with specimens of urine if available. If no urine was available blood samples were used after precipitation of proteins with acetone. Because assay sensitivity is lower for blood than urine, detection limits for positive results in the screening analysis were set lower by a factor of six for blood samples. All positive results from the screening tests were verified by more specific chromatographic methods, such as gas chromatography–

mass spectrometry (GC–MS) with deuterium labelled internal standards.

Prescription drugs, including methadone and other strong opiate analgesics, were analysed in blood after solvent extraction with *n*-butyl acetate and capillary column gas chromatography with a nitrogen-phosphorous detector. This analytical method allows simultaneous screening and quantitative analysis of about 200 different weakly acid, neutral and basic drugs as well as many metabolites. The analytical limits of quantitation for reporting positive results differed for different substances.

2.5. Statistical analysis

Means, medians, standard deviations (SDs) and upper 90th percentiles were used as descriptive statistics. Two mean values e.g. mean BAC in men and women were compared by a Student's independent *t*-test and medians were compared by Mann–Whitney test for unpaired data. Two proportions, such as male–female differences were compared by a chi-squared test. Results were considered statistically significant if $p < 0.05$ in both parametric and non-parametric tests.

3. Results

3.1. Trends in suicide deaths over time

The number of hanging suicides exceeded drug poisonings every year over the 10-year period of collection of the data (Fig. 1). In Sweden an average of 1153 suicide deaths per year were recorded and 36–42% of these were by hanging and 19–23% by poisoning. These results were remarkably consistent over the ten-year period.

3.2. Demographics of suicide victims

The mean age (\pm SD) of hanging suicides was 49 ± 19 y compared with 52 ± 17 y in drug poisonings ($p < 0.001$), as shown in Table 1. More males (80%) than females (20%) died as a result of hanging ($p < 0.001$) and the men were 4 y older (50 ± 19 y) than the women (46 ± 20 y), ($p < 0.001$). Among drug intoxication suicides, the proportion of females (53%) was higher than males (47%) and men were two years younger ($p < 0.01$). The higher percentage of men killing themselves by hanging was consistent over the ten-year study in all age groups (data not shown).

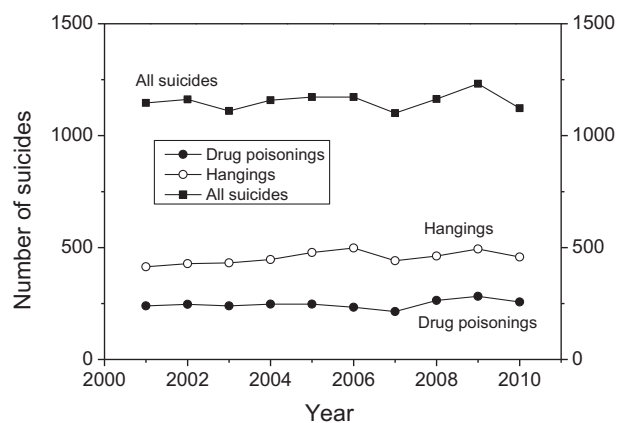


Fig. 1. Annual number of suicides (2001–2012) in Sweden in relation to those classified as hanging or drug poisoning (overdose) deaths.

Table 1
Demographics of suicide victims in Sweden when death was by hanging or drug poisoning (overdose).

Suicide method	n	Age, y	Gender		Age, y (mean \pm SD)	
		Mean \pm SD	Male (%)	Female (%)	Males	Females
Hanging	4551	49 \pm 19	3623 (80%) ^b	928 (20%)	50 \pm 19 ^c	46 \pm 20
Drug poisoning	2468	52 \pm 17 ^a	1170 (47%)	1298 (53%) ^d	51 \pm 16	53 \pm 17 ^e

^a Mean age of poisonings greater than hangings ($p < 0.001$).

^b Higher proportion of males in hanging suicides ($p < 0.001$).

^c Mean age of males higher than females in hangings ($p < 0.01$).

^d Higher proportion of females in poisoning suicides ($p < 0.01$).

^e Mean age of women higher than men in poisonings ($p < 0.01$).

The frequency distributions of age of hanging and drug intoxication suicides are compared in Fig. 2. The percentage of cases within each age group was not statistically different in relation to the method of suicide, not even among those aged <24 y, where the greatest absolute difference was found ($p > 0.05$).

3.3. Blood-alcohol concentrations

In 36% of poisoning suicides and 30% of hangings BAC at autopsy was >0.2 g/L verifying that alcohol had been consumed before death (Table 2). The mean BAC of 1.39 g/L was the same for both methods of suicide ($p > 0.05$) with no gender-related differences found ($p > 0.05$). Over the 10-year period, the median BAC per year ranged from 1.3 to 1.4 g/L in hangings and 1.1–1.5 g/L in the intoxication suicides (data not shown).

Fig. 3 shows how the percentage of alcohol positive suicides varies in relation to the age of victims and method of suicide. The percentage of victims with alcohol present increased slightly until age 45–54 y decreasing thereafter up to >75 y. This trend with age was similar for suicides by hanging and by poisoning. Victims of suicides by hanging with positive BAC were overall younger (45 ± 15.4 y) than poisoning suicides (51 ± 14.8 y), ($p < 0.001$) and in these groups the males were 6 y older than females ($p < 0.001$).

Fig. 4 plots median BAC against age of victims for both methods of suicide. The mean BAC was higher in people aged <24 y who took their lives by hanging, although this difference was not statistically significant ($p > 0.05$). The median BAC was not significantly different in relation to method of suicide when the whole material was subdivided into different age groups ($p > 0.05$).

Fig. 5 shows the relative frequency distributions of BAC in hanging and poisoning suicides and indicates a close similarity.

There were 62% of poisoning suicides with BAC >1.0 g/L and mean (median) of 1.88 g/L (1.70 g/L), $n = 556$ compared with 66% of hanging suicides with mean (median) BAC of 1.80 g/L (1.71 g/L), $n = 888$.

3.4. Other drugs used by suicide victims

As expected, poly-drug use was more common in poisoning deaths with 3.6 drugs/case compared with 1.8 drugs/case in hanging suicides. In 31% of the hanging suicides toxicology results were negative. Table 3 shows a decrease in mean age of victims as the number of co-ingested drugs detected in blood increased in the poisoning deaths but not in hangings. However, there was no significant difference between the number of drugs/case detected in men or women. The percentage of females varied from 46 to 63% in suicidal poisonings compared with 16–43% in the hangings, depending in part on the number of co-ingested drugs (Table 3).

Seven of the top-ten drugs identified in blood samples were the same for both methods of suicide, namely ethanol, paracetamol, zopiclone, propiomazine, citalopram, diazepam and alimemazine. With the exception of ethanol, the drug concentrations in blood were higher in poisonings (P) compared with hanging (H) deaths. The P/H ratios of median drug concentrations were ethanol (0.93:1), diazepam (2:1), paracetamol (4:1), propiomazine (6.6:1), alimemazine (5:1), citalopram (2.3:1) and zopiclone (5:1). There was no correlation between the mean age of victims, the proportion of males to females suicide victims or the types of drugs identified in blood samples.

4. Discussion

Although a large body of research documents the epidemiology, demographics, psycho-social factors, as well as various ways to prevent suicide, comparatively few studies have reported concentrations of drugs present in the blood of suicide victims.^{23,24} All suicides in Sweden (population 9.3 million) undergo a forensic autopsy and pathologists request the analysis of ethanol and other drugs in post-mortem blood and/or urine samples. This analytical work is done at one central laboratory and over the 10-year study period, the methods used have remained more or less unchanged. A major strength of the present study is the large sample sizes, $n = 4551$ hangings and $n = 2468$ poisoning deaths. Accordingly, the compilation of drug concentrations in femoral blood will provide a useful reference source for future studies in drug-related suicidology.

In agreement with several previous studies, ethanol was the psychoactive substance most commonly identified in blood samples in suicidal hangings and poisonings.^{4,25,26} Indeed, we found that in 62% of poisonings and 66% of hangings the BAC exceeded 1.0 g/L, which suggests that many victims were intoxicated at the time of death. Loss of inhibitions and impulsivity associated with excessive drinking may have triggered suicidal behaviour and it is

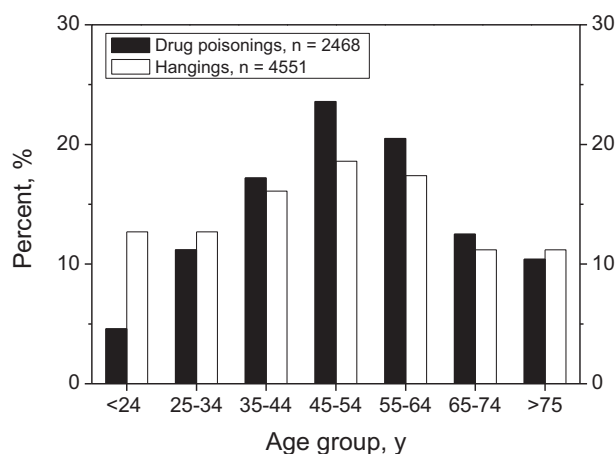


Fig. 2. Relative frequency distributions of age of victims of suicides by hanging compared with drug poisoning (overdose).

Table 2

Descriptive statistics for age, gender and blood-alcohol concentration (BAC) in hanging and drug overdose suicides. BAC considered positive if >0.2 g/L in femoral blood.

Suicide method	BAC+	BAC, g/L Mean \pm SD	Age, y Mean \pm SD	Males	Females	BAC, g/L (mean \pm SD)	
	n (%)			n (%)	n (%)	Males	Females
Hanging	1343 (30%)	1.39 \pm 0.74	45 \pm 15.4	1127 (84%) ^a	216 (16%)	1.39 \pm 0.73	1.40 \pm 0.74 ^c
Drug poisoning	891 (36%)	1.39 \pm 0.91	51 \pm 14.8	474 (53%) ^b	416 (47%)	1.41 \pm 0.92	1.35 \pm 0.86 ^c

^a Proportion of males greater than females with positive BAC ($p < 0.001$).^b Proportion of males to females not significantly different in poisoning suicides ($p > 0.05$).^c No gender difference in mean BAC in hangings or overdose suicides ($p > 0.05$).

widely known that people with substance abuse disorder are over-represented in mortality statistics.^{9,27}

With a BAC threshold of 0.20 g/L for reporting positive results, 30% of hangings and 36% of suicidal poisonings had been drinking before death. Using a lower cut-off of 0.1 g/L would have resulted in 32% alcohol positives in hanging suicides compared with 40% in drug poisoning deaths. The higher BAC cut-off of 0.20 g/L reduces the likelihood of including cases in which ethanol was produced in the body after death by microbial synthesis, especially if the body was not discovered until several days after the death.²⁸ Cases with alcohol detected in urine but negative in blood were not counted as alcohol positive cases.

Use of alcohol prior to suicidal hangings was investigated in a small Australian study ($n = 100$ victims)²⁹ and in $n = 38$ cases (38%) BAC was positive (>0.1 g/L). Subdivision of alcohol positives into six

age groups showed that the percentage positives decreased with advancing age, but the distribution of cases in relation to age and number in each age group was not reported. The much larger sample sizes in the present study showed that the percentage of alcohol positive cases increased with age up to 45–54 y and then decreased up to >75 y (Fig. 3). The median BAC also tended to decrease as age of the victims increased from 55 to 64 y and further to >75 y in both methods of suicide (Fig. 4).

Psychiatric disorder, particularly depression, is a common medical condition in today's society and a well-known risk factor for attempted or completed suicide. It is therefore not surprising that antidepressant drugs e.g. citalopram, venlafaxine, and sertraline were a common post-mortem finding.^{30,31} Several weeks of medication is required before these drugs become effective and reach optimal therapeutic concentrations in blood, which might have implications for risk of suicide.^{32,33} The presence of antipsychotic medication in blood samples, as exemplified by propiomazine and alimemazine (Tables 4 and 5) suggest a link between suicide and mental health problems.

People taking their lives by suicidal poisoning had more drugs in their blood ($n = 3.6$ per case) compared with hangings ($n = 1.8$ per case) and 31% of the hanging suicides were negative for alcohol and

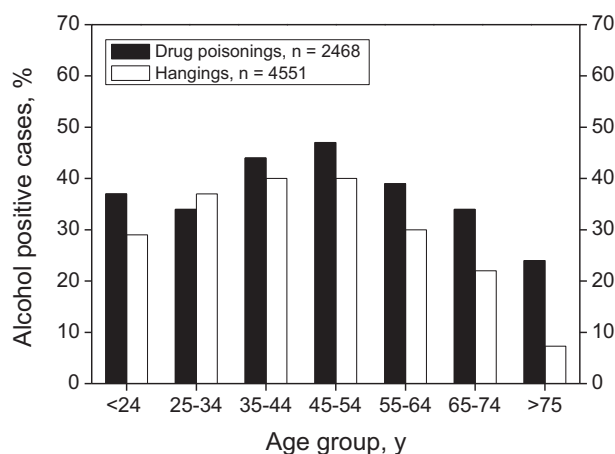


Fig. 3. Relative frequency distribution of alcohol positive suicides (BAC > 0.2 g/L) in relation to age of victims and method of suicide whether by hanging and drug poisoning (overdose).

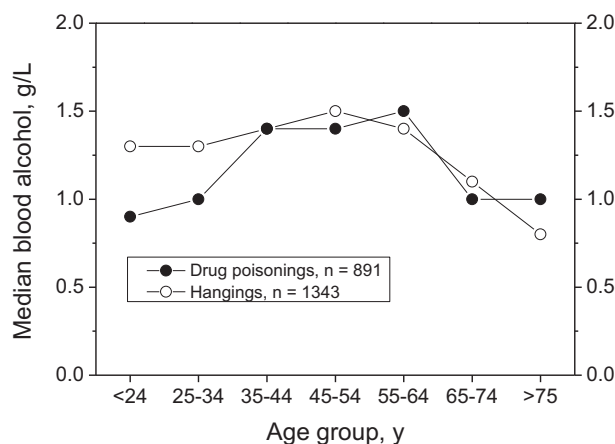


Fig. 4. Relationship between median blood-alcohol concentration (>0.2 g/L) in hanging and drug poisoning suicides in relation to age of victims.

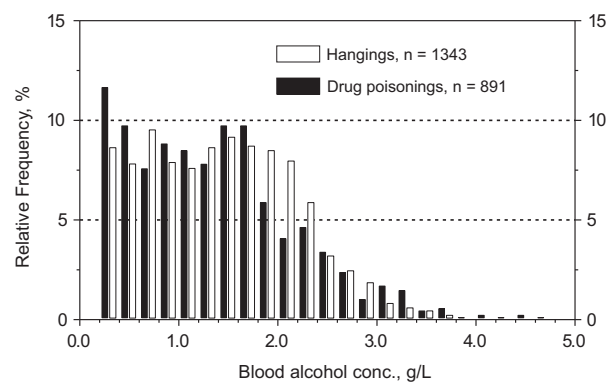


Fig. 5. Relative frequency distributions of blood alcohol concentrations (>0.2 g/L) in victims of hanging and drug poisoning suicides.

Table 3

Number of drugs identified in autopsy blood in relation to mean age (\pm standard deviation, SD) and percentage of female victims in hanging compared with poisoning (overdose) suicides.

Number of drugs	Poisoning suicides			Hanging suicides		
	n	Age (mean \pm SD)	Females (%)	n	Age (mean \pm SD)	Females (%)
1	223	57 \pm 18.6	50%	1707	49 \pm 18.2	16%
2	478	54 \pm 17.6	46%	783	52 \pm 19.3	25%
3	602	53 \pm 16.5	50%	352	50 \pm 18.1	29%
4	527	51 \pm 15.5	54%	165	51 \pm 18.7	26%
5	319	50 \pm 15.6	63%	69	49 \pm 17.5	43%
6 or more	319	48 \pm 14.9	56%	36	46 \pm 16.4	28%

Table 4
Ranking of the drugs most commonly identified in femoral blood in hanging suicides in relation to age and gender of the deceased with median and 90th percentile concentrations shown.

Hanging suicides	<i>n</i> = 4551 (%) ^a	Concentration, mg/L	Gender, <i>n</i> (%)		Mean age, y	
		Median (90th percentile)	Male	Female	Male	Female
Ethanol	1343 (30%)	1400 (2400)	1127 (84%)	216 (16%)	46	40
Citalopram	428 (9.4%)	0.3 (0.7)	312 (73%)	116 (27%)	55	56
Paracetamol	396 (8.7%)	5.0 (22)	307 (78%)	89 (22%)	61	54
Mirtazapine	355 (7.8%)	0.1 (0.3)	260 (73%)	95 (27%)	57	57
Zopiclone	257 (5.6%)	0.06 (0.3)	185 (72%)	72 (28%)	58	52
Diazepam	248 (5.4%)	0.1 (0.4)	181 (73%)	67 (27%)	45	45
Sertaline	190 (4.2%)	0.1 (0.4)	137 (72%)	53 (28%)	54	42
Venlafaxine	180 (4.0%)	0.4 (1.3)	126 (70%)	54 (30%)	50	46
Propiomazine ^b	180 (4.0%)	0.06 (0.2)	124 (69%)	56 (31%)	57	52
Alimemazine	139 (3.0%)	0.1 (0.4)	99 (71%)	40 (29%)	46	47

^a Sum of percentages exceeded 100% because many blood samples contained more than one drug.

^b Identified as dihydropropiomazine metabolite.

Table 5
Ranking of the drugs most commonly identified in femoral blood in intoxication (poisoning) suicides in relation to age and gender of the deceased with median and 90th percentile concentrations shown.

Poisoning suicides	<i>n</i> = 2468 (%) ^a	Concentration, mg/L	Gender, <i>n</i> (%)		Mean age, y	
		Median (90th percentile)	Male	Female	Male	Female
Ethanol	891 (36%)	1300 (2500)	474 (53%)	416 (47%)	51	50
Paracetamol	652 (26%)	20 (250)	268 (41%)	384 (59%)	51	54
Propiomazine ^b	605 (25%)	0.4 (1.4)	287 (47%)	318 (53%)	52	53
Zopiclone	583 (24%)	0.3 (1.6)	246 (42%)	337 (58%)	51	55
Propoxyphene	481 (19%)	2.2 (7.6)	218 (45%)	263 (55%)	48	52
Citalopram	345 (14%)	0.7 (7.5)	153 (44%)	192 (56%)	53	54
Zolpidem	319 (13%)	0.5 (2.6)	134 (42%)	185 (58%)	54	56
Diazepam	300 (12%)	0.2 (0.7)	134 (45%)	166 (55%)	48	49
Tramadol	257 (10%)	3.5 (33)	103 (40%)	154 (60%)	50	53
Alimemazine	241 (10%)	0.5 (3.0)	122 (51%)	119 (49%)	47	44

^a Sum of percentages exceeded 100% because many blood samples contained more than one drug.

^b Identified as dihydropropiomazine metabolite.

drugs. Median concentrations of the various drugs in blood samples from hanging suicides were mostly in the therapeutic range, but were appreciably higher in poisoning deaths. People killing themselves with drugs take more substances and in larger doses, which heightens the risk of an adverse drug–drug interactions and enhances toxicity.

Seven of the top-ten drugs in Tables 4 and 5 were common to both methods of suicide (hanging and drug intoxication), namely ethanol, various antidepressants and antipsychotics as well as the hypnotic zopiclone and the anti-anxiety agent diazepam. In many earlier surveys of drug use by victims of suicides in Nordic countries, propoxyphene, a centrally acting opioid, was highly prevalent.³⁴ Recent restriction on sales and prescribing of this medication, which now ranked as the 5th most common drug in poisoning deaths but was not in the top-ten among hanging suicides.³⁵ The opioid (tramadol) has been increasingly prescribed as a replacement for propoxyphene for pain management and this newer opioid ranked 9th in the intoxication suicides (see Table 5). Many of the prescription drugs found in hanging suicides probably played no part in the death and simply reflects the use of such medication among the general population and concentrations of the various substances in blood were within the therapeutic range.

Classification of a suicide as drug poisoning is not always easy and this is one of the limitations of the present study, because deaths judged as unintentional or undetermined might have been suicides.³⁶ Nevertheless, the large sample size of *n* = 2468 poisoning deaths makes up for any misclassification deficit and drugs identified in blood are an accurate reflection of those used in excessive dosage. Finding a suicide note is the most obvious way to

attribute a death to suicide, although such notes are not always written or discovered at the scene.³⁷ The cause and manner of death was determined by pathologists after careful review and consideration of police reports, interviews with a spouse, neighbours, parents, friends or relatives, medical records of psychiatric disorder etc. Review of medical records is important to ascertain any previous attempts at suicide, which is a well-known risk factor for a further suicide attempt.³⁸ The number of tablets per pack and the availability of certain over-the counter drugs frequently encountered in poisoning suicides, such as paracetamol, are now controlled in some countries in an attempt to reduce their prevalence in suicide attempts.^{39–41}

5. Conclusion

This study verifies that death by hanging was more prevalent in males (80%) compared with females (20%) by a factor of 4:1, which has been observed earlier in other countries.^{42,43} Furthermore, the results showed that in 30% of hangings and 36% of intoxication suicides victims had been drinking alcohol and many were heavily intoxicated when they died. This suggests that treatment for substance abuse might be beneficial after a failed suicide attempt as a way to lower suicide mortality. The large population size, and the use of a higher analytical cut-off (BAC 0.20 g/L) to define alcohol positives, makes the relationship between BAC and age a significant finding. Antidepressant and antipsychotic drugs were highly prevalent in blood samples from suicide victims, which indicates mental health problems as a major suicide risk factor.

Ethical approval

Application to the University Ethical Committee was not considered necessary, because none of the victims, apart from their age and gender, were identifiable from the material evaluated.

Funding

There was no external funding applied for or received for preparing this manuscript.

Conflict of interest

The authors declare that there were no conflicts of interest with any institution or organization during the preparation of this article.

References

- Hawton K, van Heeringen K. Suicide. *Lancet* 2009 Apr 18;373(9672):1372–81.
- Mann JJ, Apter A, Bertolote J, Beautrais A, Currier D, Haas A, et al. Suicide prevention strategies: a systematic review. *J Am Med Assoc* 2005 Oct 26;294(16):2064–74.
- Callanan VJ, Davis MS. Gender differences in suicide methods. *Soc Psychiatry Psychiatr Epidemiol* 2012 Jun;47(6):857–69.
- Holmgren A, Jones AW. Demographics of suicide victims in Sweden in relation to their blood-alcohol concentration and the circumstances and manner of death. *Forensic Sci Int* 2010 May 20;198(1–3):17–22.
- Ohberg A, Vuori E, Ojanpera I, Lonnqvist J. Alcohol and drugs in suicides. *Br J Psychiatry* 1996 Jul;169(1):75–80.
- Zerbini T, Ponce Jde C, Mayumi Sinagawa D, Barbosa Cintra R, Munoz DR, Leyton V. Blood alcohol levels in suicide by hanging cases in the state of Sao Paulo, Brazil. *J Forensic Leg Med* 2012 Jul;19(5):294–6.
- Brady J. The association between alcohol misuse and suicidal behaviour. *Alcohol Alcohol* 2006 Sep–Oct;41(5):473–8.
- Hawton K, Fagg J, McKeown SP. Alcoholism, alcohol and attempted suicide. *Alcohol Alcohol* 1989;24(1):3–9.
- Klimkiewicz A, Ilgen MA, Bohnert AS, Jakubczyk A, Wojnar M, Brower KJ. Suicide attempts during heavy drinking episodes among individuals entering alcohol treatment in Warsaw, Poland. *Alcohol Alcohol* 2012 Sep–Oct;47(5):571–6.
- Miller M, Azrael D, Barber C. Suicide mortality in the United States: the importance of attending to method in understanding population-level disparities in the burden of suicide. *Annu Rev Public Health* 2012 Apr;33:393–408.
- Barr B, Taylor-Robinson D, Scott-Samuel A, McKee M, Stuckler D. Suicides associated with the 2008–10 economic recession in England: time trend analysis. *BMJ* 2012;345:e5142.
- Yip PS, Caine ED. Employment status and suicide: the complex relationships between changing unemployment rates and death rates. *J Epidemiol Community Health* 2011 Aug;65(8):733–6.
- Biddle L, Donovan J, Hawton K, Kapur N, Gunnell D. Suicide and the internet. *BMJ* 2008 Apr 12;336(7648):800–2.
- Shields LB, Hunsaker DM, Hunsaker 3rd JC, Ward MK. Toxicologic findings in suicide: a 10-year retrospective review of Kentucky medical examiner cases. *Am J Forensic Med Pathol* 2006 Jun;27(2):106–12.
- Darke S, Duflou J, Torok M. Toxicology and circumstances of completed suicide by means other than overdose. *J Forensic Sci* 2009 Mar;54(2):490–4.
- Yip PS, Caine E, Yousuf S, Chang SS, Wu KC, Chen YY. Means restriction for suicide prevention. *Lancet* 2012 Jun 23;379(9834):2393–9.
- Gunnell D, Hawton K, Murray V, Garnier R, Bismuth C, Fagg J, et al. Use of paracetamol for suicide and non-fatal poisoning in the UK and France: are restrictions on availability justified? *J Epidemiol Community Health* 1997 Apr;51(2):175–9.
- CDC. Alcohol and suicide among racial/ethnic populations – 17 States, 2005–2006. *J Am Med Assoc* 2009;302:733–4.
- Kanchan T, Menon A, Menezes RG. Methods of choice in completed suicides: gender differences and review of literature. *J Forensic Sci* 2009 Jul;54(4):938–42.
- Bertolote JM, Fleischmann A, Butchart A, Besbelli N. Suicide, suicide attempts and pesticides: a major hidden public health problem. *Bull World Health Organ* 2006 Apr;84(4):260.
- Patel V, Ramasundarahettige C, Vijayakumar L, Thakur JS, Gajalakshmi V, Gururaj G, et al. Suicide mortality in India: a nationally representative survey. *Lancet* 2012 Jun 23;379(9834):2343–51.
- Jones AW, Schubert J. Computer-aided headspace gas chromatography applied to blood-alcohol analysis: importance of online process control. *J Forensic Sci* 1989 Sep;34(5):1116–27.
- Large MM, Nielsen OB. Suicide in Australia: meta-analysis of rates and methods of suicide between 1988 and 2007. *Med J Aust* 2010 Apr 19;192(8):432–7.
- Shah A, Lindesay J, Dennis M. Suicides by country of birth groupings in England and Wales: age-associated trends and standardised mortality ratios. *Soc Psychiatry Psychiatr Epidemiol* 2011 Mar;46(3):197–206.
- Hayward L, Zubrick SR, Silburn S. Blood alcohol levels in suicide cases. *J Epidemiol Community Health* 1992 Jun;46(3):256–60.
- Ingoldsby H, Callagy G. Alcohol and unnatural deaths in the West of Ireland: a 5-year review. *J Clin Pathol* 2010 Oct;63(10):900–3.
- Crombie IK, Pounder DJ, Dick PH. Who takes alcohol prior to suicide? *J Clin Forensic Med* 1998 Jun;5(2):65–8.
- Kugelberg FC, Jones AW. Interpreting results of ethanol analysis in postmortem specimens: a review of the literature. *Forensic Sci Int* 2007 Jan 5;165(1):10–29.
- Tse R, Sims N, Byard RW. Alcohol ingestion and age of death in hanging suicides. *J Forensic Sci* 2011 Jul;56(4):922–4.
- Fleischmann A, Bertolote JM, Belfer M, Beautrais A. Completed suicide and psychiatric diagnoses in young people: a critical examination of the evidence. *Am J Orthopsychiatry* 2005 Oct;75(4):676–83.
- Isacson G, Holmgren P, Ahlner J. Selective serotonin reuptake inhibitor antidepressants and the risk of suicide: a controlled forensic database study of 14,857 suicides. *Acta Psychiatr Scand* 2005 Apr;111(4):286–90.
- Isacson G, Holmgren A, Osby U, Ahlner J. Decrease in suicide among the individuals treated with antidepressants: a controlled study of antidepressants in suicide, Sweden 1995–2005. *Acta Psychiatr Scand* 2009 Jul;120(1):37–44.
- Licinio J, Wong ML. Depression, antidepressants and suicidality: a critical appraisal. *Nat Rev Drug Discov* 2005 Feb;4(2):165–71.
- Carlsten A, Waern M, Allebeck P. Suicides by drug poisoning among the elderly in Sweden 1969–1996. *Soc Psychiatry Psychiatr Epidemiol* 1999 Nov;34(11):609–14.
- Jonasson B, Jonasson U, Saldeen T. The manner of death among fatalities where dextropropoxyphene caused or contributed to death. *Forensic Sci Int* 1998 Sep 28;96(2–3):181–7.
- Bohnert AS, McCarthy JF, Ignacio RV, Ilgen MA, Eisenberg A, Blow FC. Misclassification of suicide deaths: examining the psychiatric history of overdose decedents. *Inj Prev* 2013 Jan 15. <http://dx.doi.org/10.1136/injuryprev-2012-040631>.
- Callanan VJ, Davis MS. A comparison of suicide note writers with suicides who did not leave notes. *Suicide Life Threat Behav* 2009 Oct;39(5):558–68.
- Ramstedt M. Alcohol and suicide in 14 European countries. *Addiction* 2001 Feb;96(Suppl. 1):S59–75.
- Gunnell D, Murray V, Hawton K. Use of paracetamol (acetaminophen) for suicide and nonfatal poisoning: worldwide patterns of use and misuse. *Suicide Life Threat Behav* 2000 Winter;30(4):313–26.
- Cranney M, Cranney J, Stubbs H. Limitation of over the counter sales of paracetamol. Packaging policy is unlikely to achieve its aim of reducing suicide. *BMJ* 1998 Dec 12;317(7173):1657.
- Hawton K, Bergen H, Simkin S, Brock A, Griffiths C, Romeri E, et al. Effect of withdrawal of co-proxamol on prescribing and deaths from drug poisoning in England and Wales: time series analysis. *BMJ* 2009;338:b2270.
- Sarma K, Kola S. The socio-demographic profile of hanging suicides in Ireland from 1980 to 2005. *J Forensic Leg Med* 2010 Oct;17(7):374–7.
- Shah A, Buckley L. The current status of methods used by the elderly for suicides in England and Wales. *J Inj Violence Res* 2011 Jul;3(2):68–73.